REMARKS

This amendment adds new claims 1-57 to provisional patent application serial number 60/304,255 filed under 37 CFR 1.53(c)(3) now under petition to be converted to a non-provisional application under 37 CFR 1.53(b) and to meet the requirements under 35 USC 112, second paragraph. Additionally, a section entitled summary of the invention has been added to the specification. The addition of this section includes the two paragraphs as set forth above. Lastly, paragraphs 12, 18, 21,23, 24, and 25 of the specification have been amended. Specifically, inaccurate information has been deleted from these paragraphs. Applicants contend that the amendments to the paragraphs only correct that which is set forth in the drawings and the specification as originally filed. No new matter has been added by this amendment.

It is respectfully urged that the subject application is in condition for allowance and allowance of the application at issue is respectfully requested.

Respectfully submitted,

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Marked Up Copy of Amendments pursuant to 37 CFR 1.121

Title: EXHAUST GAS PARTICULATE MEASURING SYSTEM
Application No. Unassigned
Attorney Docket No. 00-714

IN THE SPECIFICATION

Please add paragraphs to the specification after paragraph 5 and before the heading Brief Description of the Drawings on page 3 as follows:

Summary of the Invention

In one aspect of the present invention, a transient dilution air control arrangement for controlling a dilution air supply to a partial flow dilution tunnel of a gas sampling system is provided. The partial flow dilution tunnel is connected to an exhaust pipe of an internal combustion engine. The gas sampling system has a first mass flow controller operatively connected to an inlet of the partial flow dilution tunnel, a second mass flow controller connected to an outlet end of the partial flow dilution tunnel and a filter interposed the second mass flow controller and the outlet end of the partial flow dilution tunnel. The transient dilution control arrangement includes a constant mass flow stream connected to the input of the partial flow dilution tunnel and a variable mass flow stream connected to the constant mass flow stream.

In yet another aspect of the present invention, a gas sampling system for measuring particulate matter in an exhaust gas stream of an internal combustion engine is provided. The gas sampling system includes a partial flow dilution tunnel connected to the exhaust gas stream of the engine. A first mass flow controller is operatively connected to an inlet of the partial flow dilution tunnel. A second mass flow controller is connected to an outlet end of the partial flow dilution tunnel. A transient dilution air control arrangement is interposed the first mass flow controller and the inlet of the partial flow dilution tunnel and controls a dilution air supply to the partial flow dilution tunnel.

Please amend paragraph 12 of the specification as follows:

A laminar flow element 20 or other flow device is positioned in conduit 13 between the filter 18 and the engine 16. Laminar flow element 20 is a pressure differential flow element located to measure the flow of intake air 14 to engine 16. Laminar flow element 20 is connected to an airflow rate transducer enclosure 22. Located in the enclosure 22 is a pressure differential transducer 24 that converts the pressure differential across laminar flow element 20 into, for example a 0 – 5Vdc or other suitable range such as 0 – 10Vdc, an analog signal output that is transmitted through conductor 26 for use as will be described later. It should be understood that the arrangement described above is for exemplary purposes and a non-linear measurement device such as a Brandt Air Flow Meter can be used if a linearizing algorithm is used or any other flow measurement system that produces a voltage output linear to flow rate is applicable. Also the test cell 10 shows an internal combustion engine 16 having [no or] only a single turbo charger. However, in the event that an engine 16 having a dual or quad turbo charger arrangement (not shown) is to be tested the supply of intake air 14 will be separated into two or four paths respectively, each of which will contain a laminar flow element 20 up stream of each turbo charger.

Please amend paragraph 18 of the specification as follows:

<u>As shown in Fig. 2 the previous system taught in U.S. Patent 5,058,440</u>, an air flow rate meter (AM) 94, such as a laminar flow element or a Brandt [venturi meter or Daniel] flow meter, which measures the rate of incoming air supplied to the engine 16 to be sampled. Also, a fuel flow rate meter (FM) 96 is provided to measure the rate of fuel being instantaneously supplied to the engine. The air flow rate meter 94 has a signal line 98 that is connected to a signal conditioner 100, and the fuel flow rate meter 96 has a signal line 102 connected also to the signal conditioner. The signal conditioner 100 preferably has two programmable electronic processing units therein, although not shown. One of these units is adaptable to convert the voltage signal in signal line 98 by a first preprogrammed rate table to an electrical signal in a first outlet line 104 to microprocessor (PR) 84, and the other unit is

adaptable to convert the frequency signal in signal line 102 by a second pre-programmed rate table to an electrical signal in a second outlet line 106 to microprocessor 84.

Please amend paragraph 21 of the specification as follows:

As seen in Fig. 3 and shown in detail in Fig. 4, a selectable gain circuit 140 is connected to the voltage to pressure controller 130 via conductor [141] <u>160</u>. The selectable gain circuit 140 is an analog [to digital converting] <u>refining</u> circuit that receives an electrical input signal proportional to the mass flow rate of the intake air through conductor 26 from the pressure differential transducer 24. The analog signal from the pressure differential transducer 24 is received at a first input connection 142. In the event of a dual intake path for a dual turbo charged internal combustion engine 16 a second input connection 144 is provided. A switch 146 provides that the circuit 140 can be toggled between an open position for a single channel input or closed to average a dual channel input. A selectable gain switch 150 is selectable between a plurality of [course] <u>coarse</u> voltage positions 152, for example from 0 – 5Vdc maximum position to 0 – 1.67Vdc minimum position, based on the amount of intake air or particular size of engine 16 for a given test, potentiometer 154 is used to fine tune the signal thereafter. A remaining portion 156 of circuit 140 refines [and converts] the analog signal [into a digital signal] in a conventional manner with an output connection 158 supplying the [digital] <u>analog</u> signal to the voltage to pressure controller 130 via conductor 160. The selectable gain circuit 140 can be manually operated or can by controlled by the microprocessor 84.

Please amend paragraph 23 of the specification as follows:

In operation, solenoid valves 66,68,70,78 and 81 are open/closed type valves that are used for many purposes, which are apparent by an inspection of Fig. 2, such as at start up and by pass mode so that the vacuum pump 82 is not damaged. Solenoid valve 79 is included to provide a calibration loop, which by shunting the system, places the slave mass flow controller (MFC1) 60 and the master mass flow controller (MFC2) 80 directly in series

with one another. [The air flow rate meter 94 and the fuel flow rate meter 96 are operated across a full range of flows and are mathematically or physically corrected to agree with one another prior to testing.]

Please amend paragraph 24 of the specification as follows:

The gas sampling system shown in Figs 1 and 2 uses capillary tube-type thermal mass flow controllers 60 and 80 are electrically driven by the microprocessor[-based ratio-establishing processor] 84. The processor 84 controls the [receives electrical input from the signal conditioner 100 reflecting the instantaneous] total [inlet] air flow rate [information and the total inlet fuel flow rate information to the engine 16 as supplied by the meters 94 and 96 respectively. In this manner] to the partial flow dilution tunnel 38 [is provided] that is capable of re-acting to transient engine conditions while substantially eliminating particle deposition and entrainment. For example, the ratio-establishing processor 84 can apportion the control signals in the lines 86 and 88 to the master mass flow controller 80, and the control signals in the lines 90 and 92 to the lesser flow capacity slave mass flow controller 60 to establish an approximate ratio of flow of about 1.1 to 1.0, yielding a typical dilution ratio of about 10:1. This value should be controllable and variable.

Please amend paragraph 25 of the specification as follows:

Transient conditions are corrected for by the laminar flow element 20 the selectable gain circuit 140 and the transient dilution air control arrangement 110. Specifically, during a transient testing operation the laminar flow element 20 measures changes in the differential pressure across the element 20. This measurement is converted to an analog dc voltage signal by the pressure differential transducer 24. The selectable gain circuit 140 [converts and] refines the analog signal [to a digital signal] as previously discussed. The transient dilution air control arrangement 110 provides a constant mass flow stream 112 and a variable flow mass stream 114. The constant mass flow stream 112 is likely to be the greater than the variable mass flow stream 114. The constant flow stream 112 can

be varied before testing begins by way of the pressure regulating valve 116. The variable mass flow stream 114 is an extremely fast responding arrangement (15 milliseconds) that receives the signal from the selectable gain circuit 140 and establishes a dilution flow rate relative to engine flow. The quantity of flow from the variable mass flow stream 114 is inversely proportional to the flow rate of the engine 16 (i.e. maximum engine intake flow rate results in proportionally minimum mass flow rate from the variable mass low rate stream 114). In this manner a maximum and proportional rate of sample mass is being extracted from the exhaust stream 48.

IN THE CLAIMS

Please add a separate page of the specification after page 10 the claims as follows:

Claims

What is claimed is:

1. (New) A transient dilution air control arrangement for controlling a dilution air supply to a partial flow dilution tunnel of a gas sampling system, the partial flow dilution tunnel being connected to an exhaust gas stream of an internal combustion engine, the gas sampling system having a first mass flow controller operatively connected to an inlet of the partial flow dilution tunnel, a second mass flow controller connected to an outlet end of the partial flow dilution tunnel and a filter interposed the second mass flow controller and the outlet end of the partial flow dilution tunnel, said transient dilution control arrangement comprising:

a constant mass flow stream connected to the input of the partial flow dilution tunnel; and

a variable mass flow stream connected in parallel to said constant mass flow stream.

2. (New) The transient dilution air control arrangement of claim 1, wherein said constant mass flow stream includes a pressure regulating valve serially connected with a critical flow venturi.

3. (New) The transient dilution air control arrangement of claim 1, wherein said variable mass flow stream is connected in parallel with said constant mass flow stream.

4. (New) The transient dilution air control arrangement of claim 1, wherein said variable mass flow stream includes a first pressure regulating valve serially connected with a dome loaded regulating valve and a mass flow transducer.

5. (New) The transient dilution air control arrangement of claim 4, including a pressure regulating valve serially connected to a voltage to pressure controller.

6. (New) The transient dilution air control arrangement of claim 5, wherein said voltage to pressure controller is connected to and receives electrical inputs from a flow measuring device and said mass flow transducer, said flow measuring device being adapted to measure the flow of intake air to the engine.

7. (New) The transient dilution air control arrangement of claim 6, wherein said voltage to pressure controller is connected to and sends pressure signals to said dome loaded pressure regulating valve.

8. (New) The transient dilution air control arrangement of claim 7, wherein an output from said dome loaded pressure regulating valve and said critical flow venturi supply dilution air to said partial flow dilution tunnel.

9. (New) The transient dilution air control arrangement of claim 1, including a flow measuring device adapted to measure the flow of intake air, said flow measuring device being positioned in a conduit of an air intake of the engine.

10. (New) The transient dilution air control arrangement of claim 9, wherein said laminar flow element is connected to a pressure differential transducer.

11. (New) The transient dilution air control arrangement of claim 10, wherein said pressure differential transducer is connected to a selectable gain circuit.

12. (New) The transient dilution air control arrangement of claim 11, wherein said selectable gain circuit is switchable to handle one of a single channel input and a multiple channel input.

13. (New) The transient dilution air control arrangement of claim 12, wherein said selectable gain circuit is selectable between a plurality of course settings.

14. (New) A gas sampling system for measuring particulate matter in an exhaust gas stream of an internal combustion engine comprising:

a partial flow dilution tunnel connected to the exhaust gas stream of the engine;

a first mass flow controller operatively connected an inlet of said partial flow dilution tunnel;

a second mass flow controller connected to an outlet end of said partial flow dilution tunnel;

a filter interposed said second mass flow controller and the outlet end of said partial flow dilution tunnel; and

a transient dilution air control arrangement being interposed the first mass flow controller and the inlet of said partial flow dilution tunnel, said transient dilution air control arrangement controlling a dilution air supply to said partial flow dilution tunnel.

15. (New) The gas sampling system of claim 14, wherein said second mass flow controller is a master controller and the first mass controller is a slave controller.

16. (New) The gas sampling system of claim 14, wherein said transient dilution air control arrangement is positioned in close proximity to said partial flow dilution tunnel.

17. (New) The gas sampling system of claim 14, including a sampling probe being positioned in the exhaust gas stream and the partial flow dilution tunnel.

18. (New) The gas sampling system of claim 14, including a supply of scrubbed and filtered air being connected to said first mass controller.

19. (New) The gas sampling system of claim 14, including a flow measuring device adapted to measure the flow of intake air, said flow measuring device being positioned in a conduit of an air intake of the engine.

20. (New) The gas sampling system of claim 19, wherein said laminar flow element is connected to a pressure differential transducer.

21. (New) The gas sampling system of claim 20, wherein said pressure differential transducer is connected to a selectable gain circuit.

22. (New) The gas sampling system of claim 21, wherein said selectable gain circuit is switchable to handle one of a single channel input and a multiple channel input.

23. (New) The gas sampling system of claim 21, wherein said selectable gain circuit is selectable between a plurality of course settings.

24. (New) The gas sampling system of claim 14, including a vacuum pump connected to said second mass flow controller.

25. (New) The gas sampling system of claim 14, including a solenoid valve connected in parallel between said first mass flow controller and said partial flow dilution tunnel and said partial flow dilution tunnel and said second mass flow controller.

26. (New) The gas sampling system of claim 14, wherein said transient dilution air controller divides the dilution airflow into a constant mass flow stream and a variable mass flow stream.

27. (New) The gas sampling system of claim 26, wherein said constant mass flow stream includes a pressure regulating valve serially connected with a critical flow venturi.

28. (New) The gas sampling system of claim 26, wherein said variable mass flow stream is connected in parallel with said constant mass flow stream.

29. (New) The gas sampling system of claim 26, wherein said variable mass flow stream includes a first pressure regulating valve serially connected with a dome loaded regulating valve and a mass flow transducer.

30. (New) The gas sampling system of claim 29, including a pressure regulating valve serially connected to a voltage to pressure controller.

31. (New) The gas sampling system of claim 30, wherein said voltage to pressure controller is connected to and receives electrical inputs from a flow measuring device and said mass flow transducer, said flow measuring device being adapted to measure the flow of intake air to the engine.

32. (New) The gas sampling system of claim 31, wherein said voltage to pressure controller is connected to and sends pressure signals to said dome loaded pressure regulating valve.

33. (New) The gas sampling system of claim 32, wherein an output from said dome loaded pressure regulating valve and said critical flow venturi and supply dilution air to said partial flow dilution tunnel.

34. (New) A gas sampling system for measuring particulate matter in an exhaust gas stream of an internal combustion engine comprising:

a partial flow dilution tunnel connected to the exhaust gas stream of the engine;

a first mass flow controller operatively connected an inlet of said partial flow dilution tunnel;

a second mass flow controller connected to an outlet end of said partial flow dilution tunnel;

a filter interposed said second mass flow controller and the outlet end of said partial flow dilution tunnel; and

means for controlling dilution air to said partial flow dilution tunnel, said means being interposed the first mass flow controller and the inlet of said partial flow dilution tunnel.

35. (New) The gas sampling system of claim 34, wherein said second mass flow controller is a master controller and the first mass controller is a slave controller.

36. (New) The gas sampling system of claim 34, including a sampling probe being positioned in the exhaust gas stream and the partial flow dilution tunnel.

37. (New) The gas sampling system of claim 36, wherein said sampling probe is a square root extractor.

38. (New) The gas sampling system of claim 34, including a supply of scrubbed and filtered air being connected to said first mass controller.

39. (New) The gas sampling system of claim 34, including a flow measuring device connected to said means for controlling dilution air, said flow measuring device being adapted to measure the flow of intake air, said flow measuring device being positioned in a conduit of an air intake of the engine.

40. (New) The gas sampling system of claim 39, wherein said flow measuring device is a laminar flow element.

41. (New) The gas sampling system of claim 39, wherein said laminar flow element is connected to a pressure differential transducer.

42. (New) The gas sampling system of claim 41, wherein said pressure differential transducer is connected to a selectable gain circuit.

43. (New) The gas sampling system of claim 42, wherein said selectable gain circuit is switchable to handle one of a single channel input and a multiple channel input.

44. (New) The gas sampling system of claim 34, wherein said selectable gain circuit is selectable between a plurality of coarse settings.

45. (New) The gas sampling system of claim 34, wherein said means for controlling dilution air divides the dilution airflow into a constant mass flow stream and a variable mass flow stream.

46. (New) The gas sampling system of claim 45, wherein said constant mass flow stream includes a pressure regulating valve serially connected with a critical flow venturi.

47. (New) The gas sampling system of claim 45, wherein said variable mass flow stream is connected in parallel with said constant mass flow stream.

48. (New) The gas sampling system of claim 45, wherein said variable mass flow stream includes a first pressure regulating valve serially connected with a dome loaded regulating valve and a mass flow transducer.

49. (New) The gas sampling system of claim 48, including a pressure regulating valve serially connected to a voltage to pressure controller.

50. (New) The gas sampling system of claim 48, wherein said voltage to pressure controller is connected to and receives electrical inputs from a flow measuring device and said mass flow transducer, said flow measuring device being adapted to measure the flow of intake air to the engine.

51. (New) The gas sampling system of claim 50, wherein said voltage to pressure controller is connected to and sends pressure signals to said dome loaded pressure regulating valve.

52. (New) The gas sampling system of claim 51, wherein an output from said dome loaded pressure regulating valve and said critical flow venturi supply dilution air to said partial flow dilution tunnel.